

Watershed management for hurricane reconstruction and natural disaster vulnerability reduction

**USAID Contribution to the Discussion of Ecological and Social Vulnerability
Consultative Group for the Reconstruction and Transformation of Central America**

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Executive Summary

Hurricane Mitch resulted in billions of dollars in damages and thousands of lives lost. Flooding and landslides, amplified by poor environmental and land use management, were a main cause of devastation. Hurricane Mitch made clear the interrelationship between management of watersheds' upper reaches and impacts downstream. The impacts of inappropriate land management, poor agricultural practices, overgrazing, deforestation, poorly sited housing developments, and inadequate pollution control in the upper watershed are manifested in the lower basin by extremes in availability and quality of water supplies, greater vulnerability of populations and economic assets to natural disasters, reduced power-generating capacity due to sedimented water courses, and damaged coastal ecosystems. Hurricane Mitch also demonstrated the nexus between poverty, environmental degradation, and vulnerability to natural disasters, resulting in yet greater poverty.

If reconstruction is to achieve social and economic recovery, and improve resiliency to future natural disasters, watersheds must be used as the planning unit to guide policy and investment decisions. Decisions on the resources to invest on upper watershed management must take into account the crucial environmental services provided to downstream beneficiaries. Sound watershed management that combines, as appropriate, parks protection, reforestation, sustainable forestry and agricultural practices is critical to protecting downstream communities, livelihoods, agricultural lands, and economic infrastructure such as roads, ports, hydroelectric dams, and irrigation systems.

Since superior environmental and economic land management practices exist, one may ask, Why are they not more broadly adopted? The major impediments to adoption are not technical, but primarily social and political. They include:

- inadequate institutional mechanisms to support sound watershed management (e.g., watershed associations, coordination mechanisms for management of transnational watersheds);
- inadequate recognition by governments, investors, and the public of the value of environmental services provided by well-managed watersheds;
- policy constraints to investment in sound land and resource management in upper watersheds (e.g., land tenure, tree tenure, policies which encourage conversion of forests to other land uses);
- inadequate focus on market-based approaches which generate economic value to landowners while protecting watersheds (e.g., water user fees supporting water source protection, high value tree crop agriculture, eco-certified forestry); and,
- inadequate opportunity for public input into decisions that affect how watersheds are managed. People who are affected by watershed use have little or no influence on watershed management decisions.

Sound watershed management on a broader scale will not be possible as long as socio-economic issues continue to be the major impediment to improved management and public policy continues to provide inadequate incentives for environmental protection.

This paper highlights the importance of considering watersheds in reconstruction planning, natural disaster mitigation, and sustainable development; discusses major obstacles to implementing these actions; and identifies priority actions to promote sound watershed management as an integral element of reconstruction plans.

I. Introduction

Central America is one of the most disaster-prone regions of the world, experiencing earthquakes, volcanic activity, tropical storms and hurricanes. Periodic El Niño events also contribute to extreme climatic conditions, such as droughts and intense storms. The region's mountainous terrain coupled with poor environmental management -- deforestation, poor agricultural practices and unsound land use -- increases risks from flooding and landslides and intensifies the impact of droughts.

Central America has the highest rate of deforestation in the world, losing an estimated 388,000 hectares of forests annually. Subsistence agriculture on steep hillsides by poor farmers who lack viable economic alternatives results in excessive soil loss and uncontrolled water runoff from storms. The majority of higher altitude watersheds, which generate over 70 percent of electrical energy consumed in the region and which are vital for protecting water resources, are seriously deteriorated. Years of environmental mismanagement have placed the region at great risk to a storm such as Mitch, a point which was highlighted in a report released by the Central American Commission on Environment and Development (CCAD) only days before the hurricane struck. [State of the Environment and Natural Resources in Central America 1998, Central American Commission on Environment and Development, September 1998].

Central American leaders, in recognition of the critical importance of improved environmental management to the region's economies and the well being of their populations, have advanced regional environmental coordination and have made progress in several areas. These include:

- the development and consolidation of a Central American system of protected areas (Meso-American Biological Corridor) and improved management of critical coastal ecological systems that are shared by several countries;
- the development and promotion of approaches for sustainable uses of natural resources such as certified timber, organic farming, tree crop agriculture, and ecotourism;
- climate change mitigation including conservation of critical carbon sinks which protect globally important biological diversity; the establishment of a strengthened regional regulatory and enforcement framework for environmental protection; and,
- the promotion of economically and environmentally sound energy sector development.

Natural disasters, such as Mitch, however, can destroy years of development progress, impose new demands on societies, and may result in changes in development priorities with long-term consequences.

In a five-day period Hurricane Mitch pounded the Central American region with heavy rains and strong winds. Damage assessments are staggering -- over 11,000 lives lost, millions of people homeless, crops destroyed, hundreds of thousands of hectares of highly productive agricultural lands lost or degraded, major social and economic infrastructure destroyed, entire communities washed away, and expected economic losses due to disrupted agricultural and industrial production estimated at \$4.5 billion to \$5.5 billion. But the consensus is that the devastation need not have been as extensive as it was, that poor environmental management and inappropriate land use were primary factors in exacerbating the storm's impact. Hurricane Mitch demonstrated that all parts of a watershed, whether local, national or international, are inextricably linked. Thus, inappropriate land management, poor agricultural practices, and overgrazing in the upper watershed resulted in loss of life, destruction of economic infrastructure and productive assets, contaminated water supplies, reduced hydroelectric power-generating capacity, and damaged coastal ecosystems. In general, areas with sustainable forestry, shade-grown coffee, and farming systems that tied soils to hillsides withstood better the brunt of Mitch than areas without these measures.

Hurricane Mitch disproportionately affected the poor, particularly those living in floodplains or steep hillsides and those most dependent on the natural resource base for livelihood. Yet, the majority of the poor have little choice in where to live or how to earn a living, thereby intensifying the vicious cycle of poverty, environmental degradation, and destruction. Unlike many previous disasters in the region, reconstruction from Hurricane Mitch will have to proceed with a depleted stock of many of the very elements that sustain human populations -- trees, water, soil, and other natural resources. Because of the unprecedented damage to the region's natural resource base and basic infrastructure, Hurricane Mitch highlighted in dramatic fashion the indispensable role of sound environmental management in sustainable development and natural disaster mitigation, as well as the linkages between poverty and vulnerability to natural disasters. The points were reinforced at a recent multidonor-supported conference in El Salvador focusing on environmental management and natural disaster vulnerability in the Central American region. [Conference on Environmental Management and Natural Disaster Vulnerability in Central America, CCAD/IDB, San Salvador, El Salvador, March 3-5, 1999].

But watershed protection and management are not merely local or national issues. Thirty-six percent of Central America's surface area is in watersheds that cross international borders. Currently, there is no mechanism in Central America to coordinate the management of transnational watersheds. People and institutions in different countries are working independently with little concern for downstream effects.

Hurricane reconstruction efforts must consider the fundamental linkages between human activity, natural processes and the interdependencies between upper and lower sections of drainage basins. Reconstruction investment decisions must link sustainable upper watershed management to the protection of downstream investments. Watersheds need to be the prism through which to view not only the near-term reconstruction process, but longer-term sustainable development, if the region is to achieve greater resiliency to the impacts of future natural disasters.

II. Watersheds are the Necessary Planning Unit

Watersheds, being the physical unit within which all natural processes take place, are also the logical, natural planning unit for agricultural, environmental, and socio-economic development. As populations grow, and urbanization, industrialization and food production needs increase, the impacts of human activity are no longer confined to small areas, to single communities. They must be analyzed in the broader context in which they occur.

Watersheds' physical and biological resources provide goods and services to human populations, including source water protection, attenuation of natural disasters by regulating runoff, protection of coastal resources and fisheries, protection of the built environment (housing, transport, other economic and social infrastructure), and protection of highly productive lowlands agriculture. The quality and quantity of these services are affected both by natural phenomena, such as hurricanes, earthquakes, droughts, and volcanic eruptions, and by human activity. The exact economic benefits of upper watershed protection are not easily estimated nor are they required to appreciate the key contribution of well-managed upper watersheds to downstream beneficiaries. For instance, watershed degradation adversely impacts the operation of shrimp aquaculture facilities by affecting water supply, water quality, increasing production costs for sediment removal from ponds, and deteriorated health of mangrove ecosystems, which are the source of shrimp larvae for stocking ponds. The downstream costs in terms of siltation and flooding are on the order of \$10 million annually and place a tremendous financial burden on the coastal shrimp industry. Despite the benefits, stakeholders often don't appreciate what is at risk if environmental protection is not taken seriously. Unfortunately, policies and investments too often reflect this lack of appreciation. We are aware that the Netherlands Government is supporting assessments to determine the relationship between management of environmental resources and the effects of natural disasters. The results of this assessment and similar studies need to help guide reconstruction decisions.

Most would agree that the following basic elements need to be in place if management of a watershed as a unit is to be successful:

- No permanent structures in floodplains.
- All watercourses having buffer strips.
- Intensive agricultural activity not permitted on slopes greater than a set percentage reflecting land capacity.
- Clear cutting of forests limited, with forest conservation and sustainable forest management stressed.
- An institutional body formally established to address conflicts.
- Public participation of both men and women in management decisions.
- Effective management plans and enforcement of environmental and zoning regulation.
- Regional Environmental Impact Assessments used to ensure that cumulative impacts of economic activities are sustainable.

But these elements do not represent new thinking. Watershed management has been a part of the development agenda for decades. So why are we still talking about it? Unfortunately, most of the reasons also are well known and also have been part of the development agenda for decades. The next section discusses some of the reasons it has been difficult to introduce watershed management more widely and successfully. With Hurricane Mitch driving home the message on the importance of environmental management perhaps progress now will be made.

III. Impediments to Comprehensive Watershed Management

Sound watershed management requires careful consideration of scientific and technical issues, as well as the socio-economic factors of institutional structures, community support, legislative and regulatory frameworks, and economic

instruments that fundamentally influence how humans use natural resources. Many of the technical interventions needed on uplands, such as sustainable forestry, agroforestry systems, and soil and water conservation techniques, are well known and their benefits recognized. Many current programs, whether donor- or host-country funded, incorporate these elements. Unfortunately, they have been applied on too limited a scale to have significant impacts.

While the list of impediments and constraints to sound watershed management is long, in this paper we highlight three that we feel are critical: (1) inadequate economic valuation of environmental services provided by watersheds; (2) inadequate institutional structure to support watershed management and appropriate land use practices; and, most importantly, (3) inattention to the socio-economic issues fomenting the vicious cycle of poverty, degraded environment and natural disaster vulnerability (e.g., land tenure policy and inappropriate economic incentives to adopt improved agricultural and land use practices; public participation to ensure management plans can be effectively implemented).

Watersheds can range in size from international river basins covering thousands of square kilometers to micro-watersheds of only a few square kilometers. The size of the target watershed will have implications for management and technical solutions. Geographic scale is a determining factor in identifying the purpose of interventions, the level of effort, prospective participants and partners, and the potential outcomes and impacts. It is worth bearing in mind that how the issues above are addressed depends on the number of institutions involved, population, and economic development, all of which are, in large part, related to the size of the watershed.

Information needs illustrate the relevance of scale in planning and implementation. Many programs propose sophisticated information-collection systems, which are useful for large basins but are not cost-effective for managing small watersheds at the local level. These include hydrometeorological monitoring, flood hazard mapping, and developing sophisticated databases for use with geographic information systems (GIS) for disaster preparedness. Such investments only can be justified when the potential economic damage to human and social infrastructure is large. They are typically not cost-effective for managing small, isolated, rural basins that don't require and, most likely, could not accommodate such technology.

A. Inattention to fundamental socio-economic issues

Watersheds are complex physical units in and of themselves. The fact that they support human settlements and are subjected to the impacts of human activity further complicates matters and increases the difficulty of controlling environmental degradation. Unchecked human activity can amplify a watershed's vulnerability to natural disasters, while reducing its regenerative capacity. The degree of degradation will depend on income level, prevailing economic and productive activities and ecological conditions.

A recent USAID assessment of disaster recovery programs in Latin America and the Caribbean notes that "People die, are injured or lose their homes in natural disasters because they continue to build and live in unsafe structures and in vulnerable locations, and they do so because these are the most rational options available to them." [Rebuilding Shelter After Natural Disasters: Three Decades of USAID Experience in Latin America and the Caribbean, PADCO, April 1999]. As long as floodplains, steep hillsides, unstable lands, and other vulnerable sites continue to be the most viable options for the poor, there will continue to be vast devastation and loss of life in the wake of natural disasters. As Berke and Beatly note, "Poverty is the primary root of vulnerability to natural hazards in developing countries." [Berke, Peter and Timothy Beatly, *After the Hurricane: Linking Recovery to Sustainable Development*, The Johns Hopkins University Press, 1997].

Those in poverty typically do not have access to arable and safe land. Instead, they live and farm on marginalized areas, such as floodplains and steep slopes, maximizing their exposure to the next disaster, fueling the vicious cycle. They cut down vital forests for fuelwood and charcoal, and resort to slash-and-burn agriculture for food production. Population growth and land scarcity are driving rural communities to clear forests and farm on ever more fragile soils, which further lowers watershed productivity and resiliency to natural disasters. Subsistence food production (basic grains) using traditional methods and technologies is the predominant economic activity in upland areas. The resulting environmental concerns are deforestation, soil erosion, accelerated water runoff, and, to a lesser extent, non-point source pollution from agricultural chemicals. However, the steepland farmers have little capital to invest in soil and water conservation methods to correct these environmental concerns.

Lack of secure property rights has been identified as a common and important barrier to technology adoption, particularly for innovations with longer-term horizons like tree crops and improvements to natural resources. Incentives

to improve the land, for example, by constructing soil conservation infrastructure (e.g., terracing, check dams) and planting higher-valued, perennial crops decrease as uncertainty in land tenure increases. In Guatemala, for example, approximately 95 percent of rural land is without formal title. And, because it is the individual landowners who, in the end, can have the greatest impact on resource use, farm size also is an issue in terms of the effort required to educate and provide the proper incentives for individual farmers to adopt sound management practices. In Honduras, the smallest 72 percent of the farms (less than five hectares) account for only 11 percent of the farmland, while the largest 2 percent of farms, those over 100 hectares, account for more than 40 percent of the land.

To be successful, technical interventions to protect upper watersheds must improve income to landowners and producers in these areas who are motivated more by economic considerations than ecological considerations. Interventions should be developed with producers, and consider their available resources and means of production. In Honduras, USAID's Land Use Productivity Enhancement project (LUPE) worked with subsistence hillside farmers to improve soil conservation techniques and simultaneously increase crop yields and income. Since the inception of this program in the early 1980s, over 37,500 families covering more than 50,000 hectares have adopted LUPE's farming techniques and have increased their on-farm income by more than 50 percent.

Scientists have noted that virtually all the farms using recommended soil and water conservation techniques (rock terraces, vetiver grass contour buffer strips, mulching, agroforestry) under the LUPE program survived Mitch with little damage, while neighboring farms using conventional practices suffered devastating landslides that destroyed homes and degraded fields. Pre-Mitch studies of LUPE sites showed that traditional slash-and-burn sites average 92 tons/ha/year of soil loss compared to 0.9 tons/ha/year on sites with vetiver grass contour buffer strips combined with crop residue mulch. [Thurow, Thomas and James E. Smith, Jr. Assessment of Soil and Water Conservation Methods Applied to the Cultivated Steeplands of Southern Honduras. Soil Management CRSP Technical Bulletin 98-2, April 1998]. Various donors are supporting successful agroforestry and other steplands soil and water conservation programs in Honduras and other Central American countries.

Opportunities also exist for emphasizing sustainable production in response to expanding environmentally certified product markets (e.g., shade coffee, certified timber products, organic agriculture). This can result in lower enterprise production costs and higher farm-gate prices, while reducing upper watershed degradation, environmental contamination and downstream vulnerability to natural disasters. Field reports from El Salvador indicate that sun coffee areas experienced much greater losses of soils and farm productivity than shade coffee areas. Moreover, sound land use measures, such as shade-grown coffee, sustainable forestry, and agroforestry, also contribute to the mitigation of global climate change by sequestering carbon.

Most watershed management efforts in Central America also do not adequately address gender issues, which are critical to effective water management, especially in rural areas.

B. Inadequate institutional structure for watershed management

Institutional issues relate to policy, authority, capacity, and accountability. Selective issues include:

- Overlapping jurisdiction since political boundaries do not coincide with natural watershed boundaries.
- Overlapping jurisdiction with respect to laws and regulations as several ministries may be responsible for different aspects of environmental management and related areas, e.g., housing, mining, water resources. This could be referred to as an institutional vacuum because, in fact, none of these entities rarely exerts authority over watersheds, per se.
- Inadequate legislation and lack of enforcement of existing laws.
- Distorting incentive structure associated with many national policies on agriculture, forestry, land tenure, migration, etc.

There are strong decentralization tendencies in most affected countries and an increased focus on municipalities for hurricane reconstruction, including environmental management. However, even if municipalities were capable of accepting and carrying out the new roles being designed for them, they rarely have jurisdiction over an entire watershed. At the smaller end of the spectrum, at the microbasin level, watershed management is essentially a local issue.

Municipal or local governments, working with key stakeholders, may be able to exert leadership in identifying and promoting protection and sustainable management of micro-watersheds which are important within their geographic area of jurisdiction. This, however, needs to be accomplished within a larger watershed optic which generally cuts across

municipal boundaries. Mechanisms may need to be developed involving major stakeholders (e.g., watershed associations) to ensure that appropriate planning is done at both the micro and macro level, so that interventions in one portion of a larger watershed reinforce, and do not undermine, interventions in another portion. In some cases, a large watershed will cross both municipal and provincial, as well as international, political boundaries. Effective coordination and planning mechanisms are needed to ensure that upstream effects on and downstream impacts of any use are considered in planning.

In overcoming institutional obstacles, an effort needs to be made to work within the existing institutional and legal frameworks to the greatest extent possible. In some instances, the legal and institutional framework for watershed management already exists. What is lacking is information, public participation, and perhaps technical assistance to increase awareness and implementation. A case in point is the existing ability of municipalities in El Salvador, through municipal ordinances, to enter into agreements with neighboring municipalities to address common problems, including managing natural resources. However, municipal leaders lack the knowledge to take advantage of this.

C. Undervalued environmental services

To reiterate, the relationship between upper and lower portions of a watershed and the services provided by watershed management is rarely understood at the community and local levels, let alone valued. For example, stakeholders have not been able to associate the benefits of watershed protection with improved water supplies since most people don't even know where their water comes from and how it can be impacted by what happens upstream.

Generally, sustainable management of upper watersheds often is viewed as a relatively low priority compared to the presumed higher and more immediate potential returns that can be realized from downstream economic investments, such as irrigated export agriculture, shrimp aquaculture, and tourism development. Policy-makers, investors and other stakeholders often fail to take into account the crucial environmental services and economic returns provided by well protected upper watersheds in both safeguarding downstream populations and socio-economic investments, and in furnishing other essential services such as water source storage and protection and climate control.

A systems approach to valuations of the various functions of watersheds can help planners better understand the tradeoffs between options of how to use watersheds. To be most useful, valuations need to reflect as many of the goods and services of the watershed as possible, and they need to reflect how the goods and services are used by both men and women, rich and poor.

Downstream beneficiaries should contribute to upper watershed protection. Examples of where this is happening include the following. A percentage of water use fees in Quito, Ecuador, are being set aside to finance projects for the conservation and management of the watersheds that provide the city with water for household and industrial uses. Similarly, in Colombia, the Bogota Water Authority is providing funds for management of Chingaza National Park, to protect the city's key watershed. In the Brazilian State of Paraná, 5 percent of the state's sales tax collection is earmarked for municipalities in which water supply sources are located for protection of these water sources. In Costa Rica, some landowners are compensated for reforestation efforts in recognition of the water-regeneration service provided by trees. In El Salvador, the Inter-American Development Bank (IDB) is supporting a watershed management activity in the Upper Rio Lempa to address watershed sedimentation issues affecting energy production at the country's principal hydropower facility. And, in the wake of Mitch, the private sector in Honduras is supporting the reconstruction of some shrimp aquaculture production facilities damaged by the storm, including funding for elements of upper watershed restoration.

IV. Priority Actions

Lack of financial resources and inattention to the benefits of environmental management often have often resulted in not implementing watershed management activities. However, in the wake of Hurricane Mitch, donors have pledged hundreds of millions of dollars to assist in the reconstruction of social and economic systems impacted by the storm. These resources present an opportunity to replicate and "scale-up" many of the successful pilot activities implemented in the recent past, such as the LUPE program. Mass adoption of alternatives to slash-and-burn agriculture, for instance, is required if policies are to have an impact at larger scales. But replication and scale-up require overcoming numerous impediments, as discussed above.

In response, we have identified several priority actions, including:

- Strengthening municipal authority and its capacity to address land use and watershed management issues;
- Supporting sound land use planning for housing, infrastructure and sound natural resource management, and ensure public participation in watershed planning, and that the planning fully integrates gender concerns.
- Integrate local development and watershed management plans.
- Supporting policies and market-based incentives that favor reforestation, sustainable forestry, and tree crop agriculture on steep upper watersheds (e.g., land tenure, tree tenure, development of eco-certified product markets). There is potential here to promote the participation of the private sector through the climate change Clean Development Mechanism, for example.
- Requiring downstream beneficiaries to pay for watershed services, and target funding to assist subsistence farmers and other landowners in upper watersheds adopt more sustainable natural resource management practices and protect upland ecosystems, ensuring that women farmers benefit equitably from these programs.
- Supporting critical watershed protection and restoration of key ecological systems to mitigate impacts of future natural disasters (e.g., protected area management).
- Supporting local non-governmental organizations (NGOs) working in watershed management to clarify land tenure issues and facilitate access by rural farmers to formal land markets by supporting access to financing mechanisms.
- Establishing a transnational watershed management framework that galvanizes efforts among various countries around a common set of watershed management issues, and pursue establishment of agreements for management of key international watersheds.
- Pursuing a research and study agenda that incorporates the following topics: (a) economic valuation of environmental services; (b) innovative financing, including payment by downstream beneficiaries for watershed protection (e.g., Clean Development Mechanism, water use fees); (c) analysis of the relationship between land use/environmental management and the nature/magnitude of losses from natural disasters; and (d) compilation of successful experiences in market-based watershed protection.

Watershed management programs need to build upon existing national and regional environmental initiatives to the extent possible. Key regional development institutions can provide policy and technical support for national programs and transnational watersheds. These institutions may include, but not be limited to, the Central American Commission for Environment and Development (CCAD), the Regional Committee on Hydrologic Resources (CRRH), the Tropical Agricultural Research and Training Center (CATIE), the Regional Center for Prevention of Natural Disasters in Central America (CEPRENAC), and regional agricultural universities (EAP, EARTH).

V. Conclusions

The damages wrought by Hurricane Mitch brought into focus a series of uncoordinated policy, investment, and land use decisions made over decades that increased environmental insecurity and natural disaster vulnerability in Central America. Technical solutions to sound watershed management are known, are being implemented in some watersheds, and have proven to be effective measures. But technical solutions are not enough. The focus during reconstruction and beyond must be on addressing key policies and socio-economic and institutional constraints to investments in sound watershed management. Sound watershed management on a wide scale will not be realized unless these socio-economic issues are addressed and public policy provides adequate incentives for environmental protection. A focus on institutional strengthening and training is necessary. Overcoming the obstacles to sound watershed management will require action at all levels -- local, national, and regional -- and appropriate stakeholder participation at these various levels, including the contribution of downstream beneficiaries of watershed services to the cost of watershed management and protection.

Admittedly, Hurricane Mitch was one of the most intense hurricanes on record for the region. But, extreme climatic events are not uncommon in Central America. The region is faced with unacceptable vulnerability to tropical storms and hurricanes due to inappropriate land use and poor environmental management. Mitch exposed that vulnerability. Mitch also heightened that vulnerability, as excessive sediment deposition in river channels and degraded watersheds have increased the probability of flooding from much smaller storms.

Watersheds must be used as a planning framework for reconstruction if we are to achieve social and economic recovery and improve resiliency to future natural disasters. Moreover, a watershed focus reinforces several of the principal tenants of the reconstruction effort, namely, environmental security and sustainability, equity, decentralization, and the need "to build back better."